

# **Cape Cod Watershed Assessment**

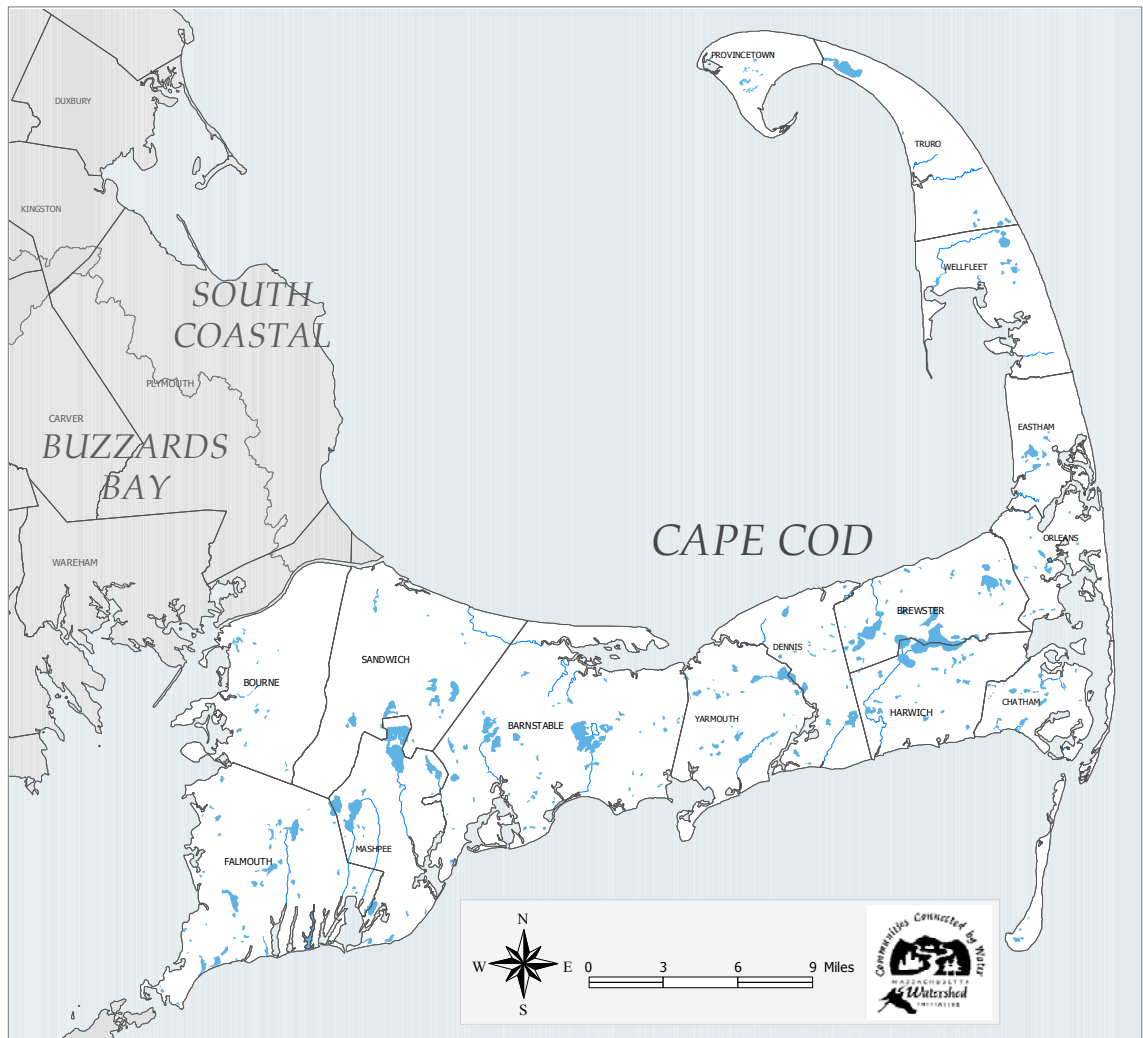
## **INTRODUCTION**

The former Cape Cod Watershed Team under the guidelines of the former Massachusetts Watershed Initiative developed this assessment. The assessment provides an overview of current natural resource conditions on Cape Cod, identifies causes and sources of water quality impairments, describes work that is underway to monitor and improve water quality, and gives recommendations to address the environmental problems. This assessment will be used to identify priority areas for conservation efforts, and develop grant proposals to secure funding for the identified projects.

This assessment is comprised of two parts. Section 1 provides an overview of the natural resources and socioeconomic conditions for all of Cape Cod. Information on research, monitoring, and mapping projects, policies, and environmental conditions are presented on a Cape-wide or regional scale.

Section 2 of the assessment presents information on a more localized scale. Cape Cod is made up of 52 subwatersheds, defined by the groundwater in each subwatershed all flowing the same direction towards the closest bay or the ocean. For planning purposes, some of these 52 subwatersheds are grouped together, resulting in 47 in this section of the assessment. Because their boundaries follow groundwater topography, many subwatersheds fall into more than one town and likewise, one town may have several subwatersheds within its borders. Section 2 of the assessment contains a fact sheet for each subwatershed that provides an overview of the area, studies conducted, water quality monitoring being done, management actions taken, and priority actions for the area. Additionally, Section 2 contains two maps for each subwatershed portraying land use and several land and management features.

**Map 1. Cape Cod Watershed**



# SECTION 1. CAPE-WIDE ASSESSMENT

## 1.1 PHYSICAL SETTING

Extending 70 miles into the Atlantic Ocean, Cape Cod is surrounded by the saltwaters of Buzzards Bay, Cape Cod Bay, the Atlantic Ocean, and Nantucket Sound. It is 440 square miles (281,600 acres) and has 586 miles of coastline. There are 15 towns on Cape Cod that comprise Barnstable County. Many towns are divided into villages, each with its own personality.

Cape Cod was formed by glaciers about 20,000 years ago. The Cape is composed of glacial end moraines, which mark the approximate locations of the ice front, and outwash plains, formed by sediments deposited by streams of meltwater from the glaciers. The result is a series of connected, broad, sandy plains and hilly terrain. The outwash deposits overlay bedrock at a depth of approximately 300 to 400 feet in the mid-Cape area. This contiguous and permeable sandy substrate comprises the matrix of the Cape Cod Aquifer. The glaciers left behind depressions that filled with water and are now known as kettle hole ponds. These ponds, along with freshwater wetlands, salt marshes, and estuaries, provide habitat for a wide variety of fish and wildlife.



Groundwater is the primary source of drinking water for the residents of Cape Cod. In 1982, the U.S. Environmental Protection Agency (EPA) designated the Cape Cod Aquifer as a Sole Source Aquifer. This designation means that the Aquifer supplies at least 50 percent of the drinking water consumed in the area above it. Sole source aquifer designation provides limited federal protection of groundwater resources that serve as drinking water supplies. Proposed federal financially assisted projects that have the potential to contaminate the aquifer are subject to EPA review. Because a large proportion of people on Cape Cod derive their drinking water from the Aquifer, the protection of groundwater quality on the Cape is critical to maintaining a healthy drinking water supply.

There are 53 coastal embayment watersheds on Cape Cod. For planning purposes these are classified into 47 major coastal embayment watersheds. Each of these watersheds is defined by the flow of groundwater from inland areas towards the coast. The United States Geologic Survey is currently refining those watershed boundaries by studying groundwater flow paths.

## 1.2 LAND USE

A great amount of development has taken place on Cape Cod and this has had a large impact on the area's natural resources. Numerous efforts are underway to manage growth and preserve open space. These efforts are resulting in planning documents, special land designations, open space acquisition, and open space prioritization projects.

Following the unprecedented growth on the Cape in the 1980's, the Cape Cod Commission was established in 1990 to serve as a regional planning and regulatory agency. The Commission is a department of Barnstable County and is made up of 19 members: a representative from each town, the County Commissioners, minorities, Native Americans, and a Governor's appointee. It has a staff with expertise in such areas as land use planning, water resources, coastal resources, wetlands and wildlife, and affordable housing. The work of the Commission falls into the categories of planning, technical assistance, and regulation.

In 1996 the Commission developed a Regional Policy Plan (RPP) to guide and manage growth and set performance standards for developments that the Commission reviews. The plan is revised every 5 years, most recently in 2001.

### 1.2.a. Local Comprehensive Plans

A tool that many Cape Cod towns use to plan to manage growth, protect the environment, and preserve community character is a Local Comprehensive Plan (LCP). Nine Cape towns have LCPs that have been certified by the Cape Commission (see Table 1). In 2002, three towns had LCPs that were under review by the Cape Cod Commission. Sandwich adopted an LCP but has not chosen to submit it for certification. Yarmouth has a plan that is done in sections and is in a perpetual state of being updated. Brewster does not have an LCP but has implemented many growth management ideas and conserved a large amount of land.

<b>Certified LCP</b>	<b>LCP under Review by the Commission</b>	<b>Uncertified LCP</b>	<b>No LCP Completed</b>
Barnstable (February 1998)	Bourne	Sandwich	Brewster
Eastham (December 1996)	Chatham		Yarmouth
Falmouth (July 1998)	Dennis		
Harwich (July 2000)			
Mashpee (July 1998)			
Orleans (July 2001)			
Provincetown (July 2000)			
Truro (March 1995)			
Wellfleet (July 1995)			

Table 1. Local Comprehensive Plans for Cape Cod Towns.

### 1.2.b. Buildout Analyses

The Cape Cod Commission, with funding from the EOE, completed a buildout analysis for each town on the Cape in 1999-2000. The buildout potential is figured if all available land were developed as currently allowed by town zoning laws. The analysis resulted in a map of each town showing developed space, protected open space, and remaining developable land, both commercial and residential. These maps are available from the Cape Cod Commission or from the planning office in each town on the Cape. Results of the analysis showed that, with no additional growth management or land protection efforts, the Cape will have 37,000 more houses and at least 50,000 more people upon reaching buildout. It also revealed that at the current rate of growth, buildout would be reached within 30 years (RPP, 2001).

### 1.2.c. Land Designations

The 2001 RPP emphasizes the importance of growth areas where development can be clustered while undeveloped areas can remain as open land. Some rules are made less stringent in designated growth areas, such as maximum building size, parking requirements, and nitrogen loading limits. Outside of growth centers, however, some regulations are more stringent than the 1996 RPP. For example, in future water supply areas, nitrogen loading will be greatly reduced and golf courses and playing fields are no longer counted as open space (RPP, 2001).

The Cape Cod Commission classified certain areas on the Cape as Significant Natural Resources Areas. The primary function of these areas is the provision of groundwater recharge, wildlife habitat, open space, scenic roadways, appropriate recreational opportunities, and protection of the Cape's natural character (RPP, 2001).

Land on Cape Cod can receive two special designations that aid in protection: the Area of Critical Environmental Concern (ACEC) and District of Critical Planning Concern (DCPC). An ACEC is an area containing highly significant environmental resources that has been designated by the Secretary of Environmental Affairs after a public nomination and review process. ACEC designation helps create a framework for local and regional stewardship of the natural resources and directs state agencies to preserve, restore, and enhance the resources within the area. Certain kinds of projects under state jurisdiction must undergo greater environmental review within an ACEC boundary. Seven ACECs currently exist on Cape Cod (see Table 2) and an additional area is in the proposal stage.

<b>Areas of Critical Environmental Concern (ACECs)</b>			
<b>Name</b>	<b>Approx. Acreage</b>	<b>Year Designated</b>	<b>Located within the Towns of:</b>
Bourne Back River and Headwater Wetlands	1,850	1989	Bourne
Inner Cape Cod Bay	2,600	1985	Brewster, Eastham, and Orleans
Pleasant Bay	9,185	1987	Brewster, Chatham, Harwich, and Orleans
Pocasset River	162	1980	Bourne
Sandy Neck/Barnstable Harbor	9,130	1978	Barnstable and Sandwich
Waquoit Bay	2,570	1979	Falmouth and Mashpee
Wellfleet Harbor	12,735	1989	Eastham, Truro, and Wellfleet

Table 2. Areas of Critical Environmental Concern on Cape Cod.

The DCPC designation is given by the Cape Cod Commission and allows a town or a group of towns to adopt special rules and regulations to protect natural, coastal, scientific, cultural, architectural, archaeological, historic, economic, or recreational resources or values of regional, statewide, or national significance. The rules then govern development in the

designated DCPC area. Six DCPCs have been designated on Cape Cod (see Table 3), although one of them was nullified in 2002 (an appeal is likely).

<b>Districts of Critical Planning Concern (DCPCs)</b>		
<b>Name</b>	<b>Year Designated</b>	<b>Located in the Town of:</b>
Bournedale	1998	Bourne
Three Ponds	2000	Sandwich
Black Beach/Great Sippewissett Marsh	1996	West Falmouth
Barnstable	2001 (nullified 2002)	Barnstable
Quivet Neck/Crowe's Pasture	2002	East Dennis
Six Ponds	2000	Harwich

Table 3. Districts of Critical Planning Concern on Cape Cod.

#### **1.2.d. Open Space Protection**

Several agencies and organizations at the federal, state, and local level are working to preserve open space. The Cape Cod Commission's Draft 2001 Regional Policy Plan stated a goal of protecting one half of the remaining developable land as permanently protected open space.

Approximately 40% of the land area on Cape Cod has been developed, 29% is permanently protected open space, and 31% is unprotected and undeveloped (RPP, 2001) (see Fig. 1). During the 1990's, more than 15,000 acres of open land was converted to development. Excluding a few large tracts such as the Massachusetts Military Reservation, most of the remaining undeveloped land is in small parcels surrounded by development. Although 60% of Cape Cod is undeveloped, that which remains is highly fragmented leading to a serious loss of contiguous habitat. This is extremely important for wildlife and rare species, such as the box turtle and a variety of inland bird species.



Large areas currently under protection on the Cape include federal, state, and private lands. The Cape Cod National Seashore contains more than 27,000 acres of natural, scenic, and recreational resources and spans six lower Cape towns. The Commonwealth of Massachusetts also owns large areas of protected open space including Nickerson State Park in Brewster, Hawksnest State Park in Harwich, Crane Wildlife Management Area in Falmouth, the Hyannis Ponds in Barnstable, and a number of other smaller parks and preserves (RPP, 2001).

### Cape Cod Land Bank

The Cape Cod Land Bank, adopted in 1998, is making an important contribution to protecting open space. The Land Bank was created by an Act of the Massachusetts Legislature that required approval of the voters in each of the Cape's 15 towns through a ballot referendum. All towns on the Cape voted to adopt a 3% real estate property tax surcharge, which was authorized by the Land Bank Act. Every town now has a land bank committee that identifies and negotiates the purchase of open space. The Cape Cod Land Bank has acquired 2,510 acres for \$64,718,000 since 1999 in towns across the Cape. That averages about \$26,000 per acre (DeConti, 2002).

### Private Land Trusts

Private land trusts are also important organizations for protecting open space on Cape Cod. A land trust was established in every Cape town by 1988, and by 2000 land trusts had protected 2,591 acres. Land trusts commonly protect land through donations and purchases of conservation restrictions, which is a less expensive method of protecting open space than outright purchase (RPP, 2001).

### Prioritizing Open Space for Acquisition

An effort to prioritize remaining open space for acquisition is being undertaken by The Compact of Cape Cod Conservation Trusts through its Cape Cod Priority Ponds Project. This project, which began in 2000, is a Cape-wide effort that has identified and ranked all remaining undeveloped and under-developed (two or more acres with an existing home) parcels around freshwater ponds. The results are intended to provide information to the Land Trusts and town Land Bank Committees about the top ranked areas for open space acquisition. Even with the Land Bank funding, there is only enough money to purchase about 15-20% of the remaining undeveloped area on the Cape, so this project is intended to make sure that consideration is given to those properties with the greatest conservation value (DeConti, 2002).

The Compact looked at 3,000 properties and chose the top 200 for further investigation. The next step of the project is to gather additional information on ownership, current use, value, and other parameters. Ultimately, working through each individual land trust, The Compact will contact property owners to inform them about the conservation values attributed to their land and explore protection options with interested owners. This phase of the project will run into 2003.

In addition to the Compact's Priority Ponds Project, there are several other efforts presently underway to prioritize open space acquisitions on Cape Cod. The Cape Cod Commission has developed a Priority Lands Acquisition Assessment Plan looking at priority conservation targets to protect water supply resources. The Compact of Cape Cod Conservation Trusts is in the process of completing a Wildlife Habitat Assessment to identify priority wildlife habitats. The Massachusetts Natural Heritage Program has recently completed a BioMap for the state, looking at priority habitat areas for rare plants and wildlife. Additionally, the state recently completed an Open Space map.

In conjunction with a region-wide evaluation of capital infrastructure and facilities, the Cape Cod Commission has begun to coalesce these natural resource inventories, plans, and other data sources into a regional “green infrastructure” or open space plan for Cape Cod. It is anticipated that this green infrastructure plan may serve as a blueprint for open space conservation as Land Bank committees, land trusts, state agencies, and others consider open space preservation on Cape Cod.

### **1.2.e. Massachusetts Military Reservation**

The Massachusetts Military Reservation (MMR) encompasses 22,000 acres on Upper Cape Cod, in the towns of Bourne, Falmouth, Mashpee, and Sandwich. The MMR has many functions, serving as a training area for the Massachusetts Army and Air National Guards and as the home of the U.S. Coast Guard Air Station Cape Cod and the Air Force 6<sup>th</sup> Space Warning Squadron (PAVE PAWS). The occupants of the MMR include 1,900 employees, 2,300 residents, and many organizations including the Massachusetts Army National Guard, Massachusetts Air National Guard, US Air Force, and US Coast Guard. The southern 5,000 acres are intensely developed. The northern 15,000 acres, called Camp Edwards, are largely undeveloped and serve as important wildlife habitat. Camp Edwards is used as an Army National Guard training area.

Military activities over the past several decades have caused soil contamination in some areas on the base and groundwater plumes emanating from old landfills, chemical spills, fuel spills, and storm drains. Due to this contamination, the MMR was added to the U.S. Environmental Protection Agency’s National Priority List (a published inventory of hazardous waste sites across the country that are required to undergo long term investigation and cleanup) in 1989, creating the MMR Superfund Site. Through the Installation Restoration Program (IRP), former oil, fuel, chemical, and hazardous waste disposal activities and releases at MMR are evaluated and addressed. The Air Force Center for Environmental Excellence (AFCEE) is the organization responsible for implementing the IRP. AFCEE works closely with the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection.

Cleanup activities on the MMR Superfund Site focus on either source areas or groundwater plumes. By the end of 2001, 80 potential source areas have been identified through records searches and field investigations. Of those, 42 sites were closed with no further action necessary, 26 sites had remedial action ongoing, nine sites had investigation ongoing, and three sites were undergoing long term monitoring. For the groundwater plumes, 15 have been identified as part of the IRP cleanup program. Of these 15, three plumes are undergoing long-term monitoring, eight plumes are undergoing long-term monitoring and cleanup with 12 treatment systems already in place, two plumes are under investigation, and five plumes have treatment systems in design.





In October 2001, the U.S. Army, the National Guard, and the Commonwealth of Massachusetts signed a Memorandum of Agreement to protect drinking water and wildlife. This agreement provides oversight of MMR training activities by a three member Environmental Management Commission (EMC). The EMC is comprised of the Commissioners of the Departments of Environmental Protection, Conservation and Recreation, and Fish and Game.

## **1.3 WATER RESOURCES**

### **1.3.a. Surface Water**

Surface water resources on Cape Cod include salt marshes, freshwater marshes, bogs, ponds, and small streams. No large streams exist on Cape Cod because of the high permeability of the Cape's sandy soils. Precipitation that does not evaporate or get transpired by plants infiltrates into the ground with little direct surface runoff. Much of the groundwater on the Cape discharges not to bodies of fresh surface water, as is common in other watersheds in Massachusetts, but rather directly to coastal waters and embayments (USGS, 1999).

There are an abundance of freshwater lakes and ponds on Cape Cod, most of which are located in kettle holes on outwash plains. At these locations, the elevations of the pond surfaces are at that of the water table. Of the 454 named freshwater lakes and ponds on the Cape, 225 are at least 10 acres or larger (Cape Cod Commission Lakes and Ponds Atlas). Three lakes are larger than 500 acres: Long Pond (743 acres) in Brewster and Harwich, Mashpee and Wakeby Ponds (729 acres) in Mashpee and Sandwich, and Wequaquet Lake (654 acres) in Barnstable. Only four percent of available freshwater on the Cape is found in surface water. Lakes and ponds are commonly used for irrigation, recreation, and fishing, but with the exception of Long Pond in Falmouth, are not used for public water supplies (USGS, 1999). For information on water quality of lakes and ponds, refer to the section on water quality in this report, the subwatershed fact sheets, or the partner reports.



#### Outstanding Resource Waters

Cape Cod has several water bodies designated as Outstanding Resource Waters (ORWs). ORWs are waters, such as public water supplies and vernal pools, that are protected by the most stringent standards because they constitute an outstanding resource as determined by their socioeconomic, recreational, ecological, and/or aesthetic values. ORWs on Cape Cod include all of the freshwater bodies within the Cape's seven Areas of Critical Environmental Concern and Long Pond in Falmouth, since it is the source for a public water supply (see Table 4) (MA DEP 2000).

<b>Town(s)</b>	<b>Outstanding Resource Waters</b>
Bourne	Freeman, Mill, Shop, and Upper Ponds, Pocasset River
Falmouth	Long Pond, Bourne, Bog, Caleb, and Hamblin Ponds
Falmouth/Mashpee	Waquoit Bay and tributaries thereto
Mashpee	Flat, Jehu, Jim, Little Flat, Sedge Lot, and Witch Ponds
Barnstable	Barnstable Harbor, excluding Freezer Point and the developed marina
Brewster/Orleans	Namskaket Creek
Chatham	Stillwater Pond, Lovers Lake, Mill Pond, Ministers Pond, Crows Pond
Orleans, Chatham	Pleasant Bay and tributaries thereto
Orleans	Little Namskaket Creek, Rock Harbor Creek, Cedar Pond, Pilgrim Lake, Quanset Pond, Crystal Lake, Paw Wah Pond, Uncle Seth's Pond, Sarah's Pond, Arey's Pond, Gould Pond, Kescago Gansett Pond, Meeting House Pond
Eastham	Boat Meadow River, Herring River, Herring Pond
Chatham, Orleans, Eastham, Wellfleet, Truro, Provincetown	Waters in and adjacent to the Cape Cod National Seashore

Table 4. Outstanding Resource Waters on Cape Cod.

### 1.3.b. Groundwater

Approximately 96 percent of available water on Cape Cod is in groundwater contained in the Cape Cod Aquifer. The Cape Cod Aquifer is made up of moraines and outwash plains, composed of sand and gravel and occasionally mixed with till and ice-contact deposits, silt, and clay. Groundwater from this aquifer is the principal source of freshwater for domestic, industrial, and agricultural use on the Cape. All of the towns on the Cape, with the exception of Falmouth, rely entirely on groundwater for their public water supply.

The Cape Cod Aquifer consists of six groundwater flow cells, or lenses. Tidal rivers cross the Cape at various points, creating these separate groundwater lenses that are hydrologically independent of each other. The six groundwater lenses include all or part of the following communities:

Sagamore Lens – Barnstable, Falmouth, Mashpee, Sandwich, Bourne, Yarmouth

Monomoy Lens – Orleans, Brewster, Chatham, Harwich, Dennis, Yarmouth, Eastham

Nauset Lens – Eastham, Wellfleet, 38% within the Cape Cod National Seashore

Chequesset Lens – Wellfleet, Truro, 70% within the Cape Cod National Seashore

Pamet Lens – Truro, 54% within the Cape Cod National Seashore

Pilgrim Lens – Truro, Provincetown, 80% within the Cape Cod National Seashore (MA DEM, 1994).

The Sagamore Lens is the largest lens of the Cape Cod Aquifer with approximately 140 million gallons of water per day slowly passing through it. It is approximately 300 feet thick. Over 70,000 homes and businesses depend on the Sagamore Lens as their source of drinking water, which is supplied through 90 municipal public water supply wells, a surface reservoir, and an estimated 10,000 private wells. In the 1999 off-season, approximately 12.6 million gallons per day were pumped from the lens by Cape municipal water suppliers. During the summer, this figure doubled (Cape Cod Commission, Sagamore Lens, 1999).

The Monomoy Lens is the second largest lens on Cape Cod with approximately 60 million gallons of water per day slowly passing through it. The lens is approximately 300 feet thick and is the source of drinking water to over 40,000 homes and businesses. Water from the lens is supplied by 49 municipal public water supply wells and approximately 1,000 private wells. In the 1999 off-season, the municipal water suppliers pumped approximately five million gallons from the lens per day. During the in-season, this figure is almost three times as high (Cape Cod Commission, Monomoy Lens, 1999).

#### Groundwater Flow

Groundwater moves through the aquifer at a speed of approximately one foot per day, in a direction that depends on the elevation of the water table at locations across the Cape. Groundwater in each of the lenses forms mounds and the water flows from the top of each mound downward, eastward, and outward. A groundwater divide that serves as the highest elevation of the water table runs from west to east along the Cape. Groundwater flows downward from either side of this divide. Water to the north of the divide tends to flow northeast towards the Cape Cod Bay and the Atlantic Ocean, while water to the south of the divide generally flows southeast to the Nantucket Sound and Atlantic Ocean (MA DEM, 1994). Because precipitation percolates rapidly into the sandy soil, the subwatersheds on Cape Cod are determined not by the topography of the land, but by the topography of the water table. Because the Cape Cod Aquifer feeds freshwater ponds and wetlands and ultimately discharges to the surrounding marine waters, contaminants that are present in the groundwater can become a problem for Cape Cod's water bodies as well.

Groundwater flow in the Pilgrim, Pamet, Chequesset, and Nauset lenses is currently being studied by the United States Geological Survey (USGS) through its Hydrologic Analysis of the Water Resources of Lower Cape Cod. The objective of this investigation is to develop a regional understanding of the groundwater flow and the sources of water to public supply wells. A regional groundwater flow model will be developed to evaluate the effects of future groundwater withdrawals, seasonal changes in groundwater pumping and aquifer recharge, extended periods of drought and high groundwater on the groundwater flow system, and, more specifically, on the sources of water to public supply wells and ponds, streams, and coastal embayments. In the towns of Eastham, Wellfleet, and Truro, data is being collected at 175 observation wells, 15 ponds, and eight stream sites. Measurements are being taken by the USGS, Cape Cod Commission, National Park Service, and the towns. A draft report will be out in June 2003 and the final report in November 2003. A similar project to study the hydrology of the Mid-Cape was completed in September 2003.

### Groundwater Recharge

Recharge to the Cape Cod Aquifer is supplied by precipitation, wastewater discharge, and road and irrigation runoff. The majority of the recharge comes from precipitation. Cape Cod receives an annual average of 45 inches of rainfall, almost half of which actually recharges the aquifer system. The remaining precipitation goes to evapotranspiration, springs, streams, marshes, and the ocean (MA DEM, 1994). Additional recharge to the water table is in the form of wastewater discharge from on-site septic systems, two septage treatment facilities in Yarmouth and Brewster, and three municipal wastewater treatment plants in Falmouth, Hyannis, and Chatham. Effluent from these treatment plants returns to the aquifer via infiltration beds. Irrigation and road run-off also percolates into the aquifer. The portion of the aquifer that contributes groundwater flow to wells, ponds, or coastal embayments is called a recharge area. A recharge area to a well is called a wellhead protection area or Zone II (Cape Cod Commission, Sagamore Lens, 1999).

### **1.3.c. Water Quantity**

The demand for water is projected to increase substantially in the upcoming decades. In 1990, the average daily demand for water was 38.73 million gallons/day (mgd) in June, July, and August and 18.68 mgd in the off-season from September through May. This equates to 8.7 billion gallons of annual public water use in 1990. Water demand in 2020 is projected to be 54.38 mgd during the summer months and 27.76 mgd in the off-season, or 12.5 billion gallons per year. This represents an increase in water usage of 43.6%. Additional demands come from the cranberry industry and golf courses (MA DEM, 1994).

Based on the current water supply, models show that there will be a water supply shortage on Cape Cod by the year 2020. While current supplies are adequate for existing peak-day demand condition, by the year 2020, demand will exceed supply. For planning purposes, by the year 2020, a total of 12 mgd or 12-14 additional future wells will be needed to meet peak-day demand for the Sagamore Lens and a total of six mgd or six to eight wells will be needed for the Monomoy lens.



The Cape experienced below-average annual precipitation in 1999, 2000, and 2001. From September through November 2001, precipitation was 50 percent below normal. Because groundwater provides most of the recharge to the aquifer, this below-average precipitation caused groundwater levels to be low. During the winter months, groundwater levels normally rise, but water levels measured in December 2001 continued to decline. In January 2002, state officials issued a “drought advisory,” classifying Cape Cod among the most severely affected areas of the state. Abundant precipitation in May 2002 eased the severity of drought conditions. The drought advisory highlighted the need to consider natural variations in groundwater levels in water resources management.

### Water Withdrawal Impacts on Ponds

Indications are that the future increases in water withdrawals will not result in significant declines in the water table regionally. Increased pumping from particular wells, however, may have significant impacts on nearby water bodies and wetlands. In 1995, The Nature Conservancy initiated a project to assess the interactions at the Hyannis Ponds (a complex of eight coastal plain ponds) among the groundwater and surface water hydrologic systems and the plant and animal communities that depend on the pond hydrology. The Hyannis Ponds complex is also the site of an active municipal wellfield. Shorelines of ponds are inhospitable to both aquatic and upland plant species due to the fluctuating water levels, but do support many rare species. If the hydrologic regime is impacted so that there is a prolonged or permanent lowering of pond levels, however, the pond-shore plant species are impacted by colonization of the zone by upland species. Some of the conclusions of the Hyannis Ponds study were that all of the ponds showed some amount of hydraulic interaction with the adjacent water table and that high pumping in the Mary Dunn wellfield resulted in a drastic lowering of pond levels (McHorney, 1998).

### **1.3.d. Public Water Supplies**

In 2001, there were 188 public water supply systems on the Cape. Of these, 26 were community public water supplies (publicly owned and operated), 151 were non-community (privately owned and operated), and 11 were non-transient non-community (residential and privately owned) (see Appendix B) (Bolivar, 2002). In 2002, there were 95 systems that were either Water Management Act (WMA) permitted or registered, which is required for those using greater than 100,000 gallons per day (see Appendix C) (LeVangie, 2002). As of 1989, 97% of the water used in public water supply systems was drawn from the Sagamore and Monomoy lenses, and 3% from the Pamet lens (MA DEM, 1994).

### Priority Land Acquisition Assessment Project

Projections of a water supply shortage by the year 2020 led the Cape Cod Commission to conduct a study of land areas that could potentially support a supply well or be used for wellhead protection. The Priority Land Acquisition Assessment Project (PLAAP), completed in 1999, focused on Upper and Mid Cape towns with public water supplies. The goal was to assist towns in the Sagamore and Monomoy lenses in prioritizing properties that may be suitable for water supply development and protection. Tracts of land in these towns were evaluated for their water supply development potential based on natural resources and land use constraints and rated as having low, medium, or high potential.

The study found that the total of high and medium potential tract area is 29,444 acres for the 11 towns covered in the study. According to the land use analysis, approximately one-third, or 10,565 acres, is already owned by these towns. Approximately two-thirds of the tracts, or 18,879 acres, is not municipally owned or currently developed (Cape Cod Commission, 1999, PLAAP). In the second phase of this project, the Cape Cod Commission completed a detailed assessment for the sites classified as having the highest potential for water supply development. Of the 99 parcels that were investigated, 84 were privately owned and totaled 1,040 acres, with a total current assessed value of \$8.4 million and a current market value of approximately \$20 million (Cape Cod Commission, 2001, PLAAP).

### Upper Cape Regional Water Supply Project

In response to the projected future water supply shortage, the Upper Cape Regional Water Supply Project on the Massachusetts Military Reservation was completed in August 2001. The Department of Defense paid for the \$20 million system to compensate surrounding towns for the contamination of 66 billion gallons of water by chemical plumes emanating from the base. The Towns of Falmouth, Mashpee, Sandwich, and Bourne were all given the option of joining the cooperative, and in the summer of 2001 all but Bourne opted to join. The new water supply system is comprised of three wells located near the northeast corner of the MMR and it makes available three million additional gallons of water per day to the three participating towns. The system has the potential capacity to produce six million gallons per day in the future. The water supply is controlled by the Upper Cape Regional Water Cooperative, which includes representatives from the Falmouth, Mashpee, and Sandwich water districts. In the spring of 2002, the Town of Bourne made plans to join the cooperative in response to the closing of three of its six wells after traces of perchlorate, a chemical used in explosives, were found in them.

### **1.3.e. Water Supply Contaminants**

Studies show that nitrogen levels are impacting the public water supply. The Cape Cod Commission established a five parts per million (ppm) nitrogen loading standard to regulate wastewater impacts. According to the Commission, in 1996, of 135 public water supply wells on the Cape, 47% were near background or unaltered water quality (below 0.5 ppm), 47% were moderately impacted (between 0.5 and 2.5 ppm), and 6% were between 2.5 and 5 ppm for nitrogen levels. According to the Department of Environmental Protection, of the 358 documented public water supply wells on Cape Cod in 2000, 12% had nitrogen levels over the EPA recommended standard (Martin, 2000). The public water supplies in the interior of the Cape have a relatively low average level of nitrogen at 1.2 ppm, but the average for private water supply wells near the coast goes up to 10 ppm (Leggett, 2000).

Nitrogen acts as an indicator that there may be other impacts from development, so it is fairly common to find additional compounds in groundwater associated with disposal of household chemicals, hazardous waste spills, underground storage tanks, and landfills. In 1996, two public water supplies were being treated for volatile organic compounds (VOCs) and 58% of the Cape's public supply wells had detectable levels of VOCs (RPP Water Resource Issues, 1996). VOCs are byproducts of industrial processes and petroleum production and can also come from gas production, urban storm runoff, and septic systems.

Concern over the above average incidence of breast cancer for most towns on Cape Cod has triggered additional study of environmental contaminants in water, as well as in other natural resources. Silent Spring Institute is conducting research on linkages between environmental factors and this disease. Their Cape Cod Breast Cancer and Environment Study, the first phase of which was completed in 1997, is looking into potential links between breast cancer and certain chemicals that reach the environment from pesticides, plastics, and detergents. Silent Spring is also looking at endocrine disrupting chemicals (EDCs) – shown in laboratory settings to cause breast cancer cells to grow – that may be present in wastewater, which then enters into groundwater and drinking water. Silent Spring is now planning a study to sample

wastewater before and after treatment at the Massachusetts Alternative Septic System Test Center on Cape Cod, where several new septic treatment technologies are being tested. Researchers hope to discover what happens to the compounds that wastewater carries within a septic system as well as when it leaves a system and enters the groundwater (Silent Spring 2002).

### **1.3.f. Wastewater**

#### Impacts on Water Quality

Many Cape Cod estuaries, bays, lakes, and ponds are suffering from decreased water quality. One of the greatest threats to water quality on the Cape is excessive nitrogen. Some of the water recharging the Cape Cod Aquifer is wastewater discharge from on-site septic systems, municipal wastewater treatment plants, irrigation, or road runoff. All of these sources contribute nitrogen to the groundwater, which in turn flows into Cape Cod's embayments. In a bay ecosystem nitrogen acts as a fertilizer and causes algae growth. An overabundance of algae leads to decreased dissolved oxygen levels in the water, degrading fish and shellfish habitat.

Wastewater discharge is a major contributor of nitrogen to coastal water bodies. Wastewater discharge to groundwater from septic systems and from the few wastewater treatment plants on Cape Cod generally makes up between 50 and 70% of the nitrogen inputs to coastal watersheds (Three Bays Preservation, Inc., 2002). The septic system of an average three-bedroom home loads almost eight and a half pounds of nitrogen into the groundwater each year. Lawn fertilizer for a home with 5,000 square feet of lawn contributes an additional three pounds (Horsley & Whitten et al., 2000).

Numerous water quality monitoring studies conducted on Cape Cod embayments indicate that excess nitrogen is entering these water bodies and degrading water quality. Monitoring results reported Water Quality & Habitat Health of the Three Bays Estuarine System (2000), for example, indicated that nutrient related environmental stress was clearly evident within the upper portions of the Three Bays System and other areas had undergone declines from historic levels. The Cape Cod Commission has conducted nitrogen loading assessments for several watersheds through their Cape Cod Surface Water Management Project (2002), Coastal Nitrogen Loading Project (2002), and other studies, and results identify several subembayments where existing or projected future nitrogen loads exceed critical limits.

#### Infrastructure

Approximately 85% of the Cape Cod population is served by individual septic systems (Leggett, 2000) and the rest are served by public or private sewer systems. The only towns on Cape Cod with public systems are Falmouth, Chatham, and Barnstable. Approximately one-tenth of Falmouth and Chatham, and approximately one-quarter of Barnstable are sewered. The sewered area in Chatham is the older section of town, near Mill Pond. Sewers run up Main Street and Cross Street, and out of town to West Chatham. The area of Barnstable that is sewered extends from the Cape Cod Hospital up Route 132 to Independence Park, with an extension that serves Barnstable Village (Prom, 2001).

The treatment plant in Falmouth currently processes 550,000 gallons per day (gpd) with a capacity of 810,000 gpd and discharges to groundwater. A \$14 million upgrade has been approved to bring the capacity up to 1,000,000 gpd in the next few years. Barnstable's treatment plant has a capacity of 2.7 million gpd. The treatment plant in Chatham can process 440,000 gpd, though it is limited to 150,000 gpd under an administrative order. Currently the plant is processing about 120,000 gpd on an annual average. The effluent is being denitrified.

#### Wastewater Management

In 2001, the Cape Cod Commission received \$50,000 from the Executive Office of Environmental Affairs Massachusetts Watershed Initiative to examine the management of wastewater on the Cape. The goal of the two-year project is to develop a regional wastewater strategy. The majority of the project will focus on collecting and analyzing data from each town related to wastewater flows. The project will also identify potential sites for wastewater treatment and disposal and develop a model wastewater district. The project started with the formation in 2002 of a Cape Cod Wastewater Implementation Committee (WIC), an advisory committee to Barnstable County. The WIC is comprised of representatives from each town, the Cape Cod Commission, Barnstable County Department of Health and the Environment, Cape Cod Chamber of Commerce, Massachusetts Department of Environmental Protection, and the Waquoit Bay National Estuarine Research Reserve. The mission of the WIC is to facilitate and encourage towns to initiate wastewater management strategies that protect public health, restore coastal and fresh surface water quality, preserve community character, and provide growth center infrastructure.

Concerns over the high costs of removing nitrogen from wastewater is prompting the development of a bill to be filed with the Massachusetts Legislature in 2003 to create a framework for a Cape Cod regional wastewater management authority. Cape communities may vote to join the authority, which would have the power to raise money and issue bonds to fund the effort to upgrade the Cape's wastewater treatment and disposal systems. The WIC is providing input into the development of the bill.

#### **1.3.g. Massachusetts Estuaries Project**

In a widespread effort to begin to address nitrogen loading in coastal water bodies, the Department of Environmental Protection, in conjunction with the University of Massachusetts-Dartmouth, is undertaking the Estuaries Project, Southeastern Massachusetts Embayment Restoration. The goal of the project is to develop critical nutrient loading thresholds for each of 89 embayments throughout the region. Developing these thresholds will aid in water resources planning and will support federal requirements for the development of Total Maximum Daily Loads for impaired surface waters. The \$12.5 million study began in 2002 and will continue for six years.

Three years of water quality monitoring data is necessary for an embayment to be evaluated through the Estuaries Project. For estuaries on Cape Cod that do not currently have three years of data, towns are partnering with volunteer groups to initiate monitoring programs.



Another data component for the Estuaries Project is surface water flow. Embayment health is generally based on the water quality conditions in near shore waters and harbors. These waters are most likely to be impacted by excessive nutrient loading originating from local land uses. Since surface water is an important transport mechanism of nutrients to coastal waters, stream flow data coupled with water quality data helps determine nutrient loading. The USGS currently has 19 stream flow gauges deployed on Cape Cod, with plans for another 10 to 15 to be deployed soon.

### **1.3.h. Water Quality Monitoring**

Water quality data for ponds and embayments across the Cape is being collected by a variety of citizen groups and government agencies. Citizen volunteer water quality monitoring groups sample water bodies Cape-wide for such parameters as water clarity, temperature, salinity, dissolved oxygen, and nutrients. Town health departments routinely sample swimming beaches and ponds to determine if the level of fecal coliform bacteria is safe for swimmers. Barnstable County Department of Health and the Environment conducts water quality studies as well. The Massachusetts Division of Marine Fisheries conducts fecal coliform studies in order to open and close shellfish areas.

The Cape Cod Commission sampled ponds for fish toxics under an EPA grant beginning in August 2001. The ponds from which fish were collected are Long Pond, Cliff Pond, and Sheep Pond in Brewster; Hamblin Pond and Shubael Pond in Barnstable; Peter's Pond and Lawrence Pond in Sandwich; and Hinkley's Pond in Harwich. Results were submitted to the Massachusetts Department of Public Health in 2001 for use in determination of fish consumption advisories.

The Massachusetts Department of Environmental Protection, Division of Watershed Management (DWM) has completed studies on several lakes and ponds on Cape Cod. The agency historically sampled six Cape water bodies for fish toxics. These are: Shubael Pond and Lake Wequaquet in Barnstable, John's Pond and Mashpee-Wakeby Ponds in Mashpee, Great Pond in Eastham, and Snake Pond in Sandwich. The DWM also sampled John's Pond, Ashumet Pond (Mashpee), and Mashpee/Wakeby Ponds in 1999 for fish toxics. In 1999, the DWM conducted studies on five lakes and ponds that are listed on the State 303(d) List of Impaired Waters to provide data in support of the DWM Total Maximum Daily Load (TMDL) program. These water bodies are: Lower Mill Pond, Upper Mill Pond, and Walkers Pond in Brewster, Santuit Pond in Mashpee, and Ryder Pond in Truro. The DWM also completed Diagnostic/Feasibility studies on five Cape Cod lakes in the past: Bearse Pond, Red Lily Pond, and Shallow Pond in Barnstable, Great Pond in Eastham, and Sheep Pond in Brewster. Table 5 summarizes the ponds and lakes sampled by the DWM and the Cape Cod Commission (CCC).

<b>Town</b>	<b>Name of Waterbody</b>	<b>Study Conducted (Agency)</b>
Barnstable	Bearse Pond	Diagnostic/Feasibility Study (DWM)
Barnstable	Hamblin Pond	Fish toxics – 2001 (CCC)
Barnstable	Lake Wequaquet	Fish toxics (DWM)
Barnstable	Red Lily Pond	Diagnostic/Feasibility Study (DWM)
Barnstable	Shallow Pond	Diagnostic/Feasibility Study (DWM)
Barnstable	Shubael Pond	Fish toxics (DWM), fish toxics – 2001 (CCC)
Brewster	Long Pond	Fish toxics – 2001 (CCC)
Brewster	Lower Mill Pond	Data to support TMDL – 1999 (DWM)
Brewster	Upper Mill Pond	Data to support TMDL – 1999 (DWM)
Brewster	Sheep Pond	Diagnostic/Feasibility Study (DWM), fish toxics – 2001 (CCC)
Brewster	Walkers Pond	Data to support TMDL – 1999 (DWM)
Brewster	Cliff Pond	Fish toxics – 2001 (CCC)
Eastham	Great Pond	Fish toxics (DWM) Diagnostic/Feasibility Study (DWM)
Harwich	Hinkleys Pond	Fish toxics – 2001 (CCC)
Mashpee	Ashumet Pond	Fish toxics – 1999 (DWM)
Mashpee	John's Pond	Fish toxics – 1999 (DWM)
Mashpee	Mashpee/Wakeby Pond	Fish toxics – 1999 (DWM)
Mashpee	Santuit Pond	Data to support TMDL – 1999 (DWM)
Sandwich	Snake Pond	Fish toxics (DWM)
Sandwich	Peter's Pond	Fish toxics – 2001 (CCC)
Sandwich	Lawrence Pond	Fish toxics – 2001 (CCC)
Truro	Ryder Pond	Data to support TMDL – 1999 (DWM)

Table 5. Ponds and lakes sampled for fish toxics by the MA Department of Environmental Protection Division of Watershed Management and the Cape Cod Commission.

In an effort to increase the amount of water quality data on and stewardship of ponds and lakes, the Ponds and Lakes Stewardship Program (PALS) began in 2000. Initiated by the Massachusetts Watershed Initiative by a Stewardship Grant and coordinated through the Cape Cod Commission, PALS encourages citizens to volunteer for the collection of water quality information and become educated about its use for advocacy for the ponds that they care about. Government environmental agencies and universities partner through PALS to provide funding, technical assistance, laboratory analysis, and data analysis skills to assist citizens and towns with appropriate interpretation of water quality data, watershed information, and consideration of various pond management strategies. Partnering with non-governmental organizations, PALS provides citizens with organizational assistance to form lake associations and other stewardship entities (Eichner 2002).

As part of the PALS program, a representative survey of freshwater ponds was conducted across Cape Cod in 2001 to compile a “Water Quality Snapshot.” A total of 189 ponds were



sampled, for laboratory analysis of nutrients and dissolved oxygen profiles. Results indicated some trends in pond water quality. The Upper Cape, which is the most heavily populated area, had a larger proportion of nutrient impacted ponds. Ponds with areas of less than 15 acres were more likely to be nutrient enriched than larger ponds. One-third of the ponds were acidic and one-quarter were highly acidic, likely to be a result of natural processes. The Water Quality Snapshot was repeated in 2002, with the collection of water quality data from more than 170 ponds.

The National Park Service water quality lab at the Cape Cod National Seashore received funding in 2002 from the Community Foundation of Cape Cod and Massachusetts Coastal Zone Management to assist volunteer monitoring groups with data analysis.

A listing of the Cape Cod water bodies that have been assessed or are in need of an assessment is provided in Appendix D: Cape Cod Waterbody Database. Appendix E is a database of water quality reports and other environmental studies that have been conducted on Cape Cod.

### **1.3.i. Impaired Waters**

Section 303(d) of the Clean Water Act requires states to identify water bodies that are water quality impaired and maintain a list of these water bodies. Water bodies for which studies show they are not meeting Surface Water Quality Standards are placed on the 303(d) List of Water Quality Limited Water bodies.

There are 49 water bodies on Cape Cod that are on the 1998 303(d) List of Impaired Water bodies (see Appendix F). Of those, 10 are freshwater lakes and ponds, 22 are creeks or rivers, and 17 are harbors or coastal embayments. Because the 303(d) List is based solely on available data, water bodies that have impaired water quality but have not been sampled and tested yet do not appear on the List. The cause of impairment for most of the listed water bodies on Cape Cod is “pathogens,” such as fecal coliform bacteria. Other types of impairments for which Cape Cod water bodies are listed are noxious aquatic plants, nutrients (such as phosphorus and nitrogen), and organic enrichment/low dissolved oxygen. The 2002 303(d) List became available in 2003.

### **1.3.j. Fish Consumption Advisories**

Currently there are Massachusetts Department of Public Health (MDPH) fish consumption advisories for seven water bodies on Cape Cod because of elevated levels of mercury. The water bodies are: Ashumet Pond (Mashpee/Falmouth), Hamblin Pond (Barnstable), John’s Pond (Mashpee), Mashpee-Wakeby Pond (Mashpee/Sandwich), Peter’s Pond (Sandwich), Snake Pond (Sandwich), and Lake Wequaquet (Barnstable). The advisories vary from pond to pond, ranging from a warning to children younger than 12 years, pregnant women, and nursing mothers not to eat any smallmouth (or in other cases largemouth) bass from the

waterbody, up to a warning to the general public to limit consumption of all fish from the waterbody to two meals per month. (Detailed warnings are available at <http://www.state.ma.us/dph/beha/fishlist.htm>). Additionally, the Brewster Board of Health recently identified Sheep Pond in Brewster as having elevated mercury levels and recommended reducing the consumption of fish from the pond.

### **1.3.k. Beaches Act**

In the summer of 2001, there were 51 Cape beach closures to swimming due to high bacteria counts. The Beach Act, passed in Massachusetts in 2000, requires weekly water testing at swimming beaches for enterococcus bacteria levels, and a temporary beach closing if bacteria levels from a single water sample are higher than the maximum level (104 bacteria colonies per 100 milliliters of water) set by the Environmental Protection Agency. By the end of August 2001, officials had taken 2,511 fresh and saltwater samples from Cape



Cod beaches, leading to 51 closures for a two percent failure rate. Only three beaches were closed more than once — Colonial Acres Creek and Colonial Acres Bridge in Yarmouth and Ryder Street Beach in Provincetown. The enterococcus counts at Cape beaches that resulted in closures ranged from 106 to more than 400 colonies. In the majority of the cases, the high readings disappeared when a second sample was taken the following day (Leaning, 2001, “No New”).

Most of the beach closures in 2001 appeared to be tied to heavy rainfall and high humidity and temperatures. It has not been determined if these bacteria levels are due to animal (waterfowl) feces in the water or more persistent pollution problems, such as leaching from nearby septic systems.

The Barnstable County Health Department expanded their beach monitoring program in Summer 2002. Monitoring is now conducted at semi-public beaches as well as the public beaches that were tested in 2001. The expanded monitoring could result in the collection of as many as 450 samples per week. Results of the 2002 sampling season can be viewed at <http://www.barnstablecountyhealth.org/beachsampling.htm>. The Health Department is also conducting sanitary surveys of all major public beaches to identify sources of high bacterial counts.

### **1.3.l. MWRA Ocean Outfall Pipe**

In September 2000, the Massachusetts Water Resources Authority’s ocean outfall pipe began discharging sewage effluent from the Boston area into Massachusetts and Cape Cod Bays. The Center for Coastal Studies is monitoring the water quality in Cape Cod Bay for adverse impacts from the discharge. By August 2001, the highest reading of enterococcus bacteria in the effluent since the system went on line was 16 colonies per 100 milliliters of water, well

below the state threshold of 104 colonies per 100 milliliters. About 85 percent of the samples had readings too low to measure at all (Leaning, 2001, “No New”).

### **1.3.m. Discharge Permits**

There are four surface water discharge sources on Cape Cod holding National Pollutant Discharge Elimination System (NPDES) permits. The only facility holding a major NPDES permit is the Canal Electric Company, Cape Cod Canal. The rest are minor permits, and these include Northeast Petroleum, discharging into the Cape Cod Canal, the Aquaculture Research Corporation, discharging into Chase Garden Creek, and the Sandwich State Fish Hatchery, discharging into Dock Creek.

In 2001, 52 entities on Cape Cod held Groundwater Discharge Permits. A listing of current permits can be obtained from the MA Department of Environmental Protection Regional Offices, Bureau of Resource Protection.

### **1.3.n. Stormwater**

Most towns on Cape Cod are covered under Phase II of the NPDES stormwater program. Phase II requires small municipal separate storm sewer systems (MS4s) located in “urbanized areas” to implement a stormwater management program as a means to control polluted discharges from the sewer systems. In accordance with the results of the 2000 Census, all towns on Cape Cod from Bourne to Eastham have Urbanized Area (UA) and therefore fall under the Phase II Rule. These towns are required to have stormwater management programs for their UAs that address the following six elements: 1) public education and outreach, 2) public participation/involvement, 3) illicit discharge detection and elimination, 4) construction site runoff control, 5) post-construction runoff control, and 6) pollution/prevention/good housekeeping. Towns must have a permit by March 10, 2003, and have until 2008 to fully implement the MS4 programs to comply with the permit. Maps of the urbanized areas in each town that fall under the Phase II Rule can be viewed on the Internet at <http://cfpub.epa.gov/npdes/stormwater/urbanmapresult.cfm?state=MA>.

## 1.4 COASTAL ISSUES

Water quality problems in the surface and groundwater on Cape Cod ultimately have an effect on coastal water quality and coastal resources. Nitrogen in the Cape Cod Aquifer eventually flows into the embayments. In a bay ecosystem nitrogen acts as a fertilizer and causes algae growth. Increased amounts of nitrogen can lead to an overabundance of algae, reducing light transmission through water. This decrease in light can lead to the death of eelgrass beds that serve as nursery habitat for several species of fish and shellfish. Additionally, excessive algae growth decreases the amount of dissolved oxygen in the water as the algae consume the oxygen during decomposition. Algae can also sink to the bottom in shallow bays and smother shellfish (Buzzards Bay Project, 2001). Benthic algae has replaced eelgrass in many estuaries on Cape Cod. Increases in shellfish bed closures, extensive losses of eelgrass beds, and decreases in dissolved oxygen concentrations are well documented in some Cape Cod subembayments. A survey of shellfish constables on the Cape and Islands in the late 1990's found that 70% had seen a decline in eelgrass during their tenure. Sixty-seven percent saw algal growth on the eelgrass.



### 1.4.a. Shellfish Industry



Water quality impairment due to fecal coliform loading has a large effect on shellfish growing areas. Shellfish areas are classified according to the impacts they receive from fecal coliform pollution sources. Approved areas are those in which shellfish can be harvested under all conditions. Conditionally approved areas are those in which a predictable condition exists (such as the amount of rainfall) that causes the area to be closed for part of the year. A restricted area denotes one where there is a water quality problem and shellfish may only be harvested for transplants, relays, or transportation. A prohibited classification indicates that the water quality is poor and no shellfish operations can take place in the area. Lastly, an area under management closure is one where an assessment of the fecal coliform sources of the area has not been completed, so it is closed though not necessarily because there is a pollution problem. Table 6 shows the amount of area on the Cape in each of these categories as of January 2001.

Approved	420,509	acres	98.3%
Conditionally approved	4,632	acres	1.1%
Restricted	442	acres	0.1%
Prohibited	2,060	acres	0.5%
Under management closures	43	acres	>0.1%

Table 6. Cape Cod Shellfish Area Classifications as of January 1, 2001 (Churchill, 2002).

Cape Cod's tidal areas have the largest traditional and cultivated shellfishing industry of any coastal region in Massachusetts (RPP, 2001). In 1999, the commercial shellfish aquaculture licenses issued in Barnstable County covered 584.7 acres. The estimated economic value of cultured shellfish in 1999 was \$1,468,728, an increase from \$1,083,455 in 1990. During the late 1990's, the landed value for commercial and recreational shellfish on Cape Cod was, on average, \$7,368,000 per year (Churchill, 2001).

Shellfish bed closures due to water quality impairments are increasing. In 1980, about 1,000 acres were closed to shellfishing, whereas by 1990 approximately 5,500 acres were closed (Woods Hole Research Center, 2000). Additionally, the length of time for which shellfish beds are closed seasonally is expanding.

#### 1.4.b. Boating Impacts

Because of their ecological or recreational significance, some water bodies are designated a No Discharge Area by the state. A No Discharge Area is a body of water in which the discharge of all boat water, even if it is treated, is prohibited. This designation is made if a community or the state believes that the waters are ecologically and recreationally important and merit further protection than the current laws provide. There are six No Discharge Areas on Cape Cod. The areas are all of Buzzards Bay, Waquoit Bay in Falmouth, the Three Bays/Centerville Harbor area in Barnstable, the Coastal Waters of Harwich, Stage Harbor in Chatham, and Wellfleet Harbor. Twelve towns on the Cape operate 33 shore-side and floating pump-out facilities.

Massachusetts Coastal Zone Management is working to reduce the impacts of boating on coastal water quality through the Clean Marine Initiative. Under their "4 the Environment"



grant program, communities can receive grants to replace old, polluting 2-stroke outboard motors with new, clean 4-stroke engines on municipal vessels. In 2000, the towns of Barnstable, Brewster, Dennis, Falmouth, and Wellfleet each received between \$2,400 and \$4,050 under this program.

#### 1.4.c. Harbor Management Plans

Stage Harbor and Provincetown Harbor are the only areas on the Cape with harbor management plans



approved by Massachusetts Coastal Zone Management. Wellfleet is currently working on a management plan for Wellfleet Harbor.

#### **1.4.d. Shoreline Change**

Cape Cod's shorelines are impacted by coastal erosion and interruptions to sediment transport. Cape communities exhibit a long-term shoreline change rate of  $-0.53$  feet/year. Some communities, however, do exhibit long-term accretion, while others exhibit long-term erosion. Management strategies such as the armoring of sediment sources (i.e. coastal banks) and reconstructing groins may cause serious downdrift erosion problems (O'Connell, 1999).

#### **1.4.e. Salt Marsh Assessments**

Massachusetts Coastal Zone Management, in cooperation with several project partners, is conducting a Salt Marsh Ecological Assessment Project on the Cape Cod Bay shore of Cape Cod. It is a long term study on two types of degraded salt marshes – selected sites primarily affected by land use and/or non-point source pollution, and selected sites primarily affected by tidal restriction. The project began in 1999 will continue through 2003. A summary of 1999-2001 data became available in 2003.



The Cape Cod Atlas of Tidally Restricted Salt Marshes was completed by the Cape Cod Commission in 2001. The atlas identifies sites in each town (114 sites total) where salt marshes have been impacted by transportation related facilities, such as roads, railroads, causeways, and footpaths. Infrastructure built to support cranberry farming operations on the Cape were also considered in the development of the atlas. The purpose of the atlas is to identify and inventory sites on Cape Cod that are tidally restrictive of salt marsh, so that

municipalities have baseline data with which to prioritize and develop restoration projects. One hundred and fourteen sites were identified as sites where infrastructure crosses tidal creeks or channels and causes a restriction. Additional sites for Falmouth and Bourne can be found in the Atlas of Tidally Restricted Salt Marshes – Buzzards Bay Watershed, Massachusetts, published in July 2002 by the Buzzards Bay Project National Estuary Program.

#### **1.4.f. Coastal Monitoring**

##### Ecosystem Monitoring

The Cape Cod National Seashore is the site of a prototype monitoring program under development for the Atlantic and Gulf Coast region. The program is being designed to detect ecosystem changes, examine contributing factors and consequences of ecosystem changes, and inform park management of the critical issues that such ecosystem changes represent. Monitoring data will provide a scientific basis for management decisions leading to effective protection and restoration of coastal ecosystems. Protocols are currently being developed to



monitor estuarine nutrient enrichment, estuarine fish and decapod crustaceans, sediment and benthic fauna contaminants, shoreline change, water quality, groundwater hydrology, freshwater fish, aquatic invertebrates, amphibians, waterbirds, landbirds, and red foxes and coyotes (National Park Service, 2002).

#### Status Report of Coastal Waters

Massachusetts Coastal Zone Management is in the process of developing a status report on the condition of the coastal waters of Massachusetts. This document will translate recent data and information from local, regional, and statewide monitoring programs into an evaluation of the status and/or ecological condition of the coastal waters. The project will be completed in two phases. The first phase involves synthesizing and translating Massachusetts monitoring data obtained through the United States Environmental Protection Agency's National Coastal Assessment Program. In the second phase, information obtained from scientific reports, other established databases, and recent and ongoing monitoring efforts will be integrated. The report is intended to be of greatest use to coastal managers, scientists, teachers, and the interested public. Its anticipated completion date is the end of 2003.

#### **1.4.g. Offshore Impacts**

Potential impacts to various coastal resources by the proposed Cape Wind Energy Project are currently being evaluated. The project, as currently proposed by Cape Wind Associates, would consist of an array of 170 windmills located over a 28 square mile area on Horseshoe Shoal in Nantucket Sound. The turbines would transmit wind generated electricity to shore by two submarine cable systems, landing in the town of Yarmouth. The electricity would ultimately go into the NSTAR New England transmission system for distribution to all users, including those on Cape Cod and the Islands. The 400 feet tall turbines would be visible from the shorelines of Barnstable and Yarmouth. Project proponents and opponents are looking into potential impacts of the project on fisheries, wildlife, and recreational boating in Nantucket Sound. The proposal is currently under review by the Massachusetts Environmental Policy Act (MEPA) office and EOEA agencies.

Dredging is proposed at many locations on Cape Cod to improve navigation and/or improve water circulation. Locations for the disposal of dredged materials on the Cape, however, are very limited. The only permitted disposal sites for contaminated sediment are the Bourne landfill and the offshore Cape Cod Disposal Site, used for the disposal of fine-grained dredge sediments from harbors on the Bay side. The offshore Buzzards Bay Disposal Site will soon also be available. There is a need for an approved open water disposal site for the south side of the Cape. Beach disposal of clean, compatible material is permitted at several sites.

### **1.5 HABITAT AND BIODIVERSITY**

The amount of wildlife habitat on Cape Cod has been drastically reduced in the past few decades. Between 1971 and 1990, 24% of the forestland on the Cape was developed, reducing forested areas by 35,458 acres. Since 1990, another 15,000 upland acres have been developed. Additionally, there are many ponds, wetlands, and vernal pools that have become

stressed and lost some of their ecological functions due to groundwater withdrawals or shoreline development (RPP, 2001).

There are numerous rare and endangered plant and animal species on Cape Cod. Four towns on Cape Cod—Barnstable, Brewster, Wellfleet, and Truro—are on the statewide top ten list for the largest number of state listed rare species records. Barnstable is one of only five towns in the Commonwealth with more than 100 records of rare plant and animal species (Barbour et al., 1998). The document Our Irreplaceable Heritage identified areas statewide that should be considered Priority Habitats for rare and vulnerable species, and concluded that in the Cape Cod and Islands ecoregion, less than 50% of these areas are currently protected. Additionally, the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries & Wildlife recently conducted the BioMap project to identify and map the areas most critical to protecting the state's biodiversity. A map showing protected and unprotected core habitat areas for rare or endangered species on Cape Cod is available.

### **1.5.a. Invasive Species**

Some introduced non-native plant species such as purple loosestrife and *Phragmites* are considered invasive species that can harm wildlife habitats. These invasive plants can spread quickly since they grow and mature rapidly and have few natural pests or diseases to help control them. Their rapid expansion can alter wildlife habitats by replacing a rich native plant biodiversity, sometimes including rare species, with a monoculture of the alien plant species. This reduction in the plant diversity can lead to corresponding declines in associated animal communities (Hurley, 2002).

Invasive aquatic species are also an issue on Cape Cod. The Cape has a unique assemblage of ponds that support globally rare species. However, when the hydrologic regime is altered (i.e. from land use), a pond becomes more susceptible to invasive species. Invasive aquatic species have become established in many ponds in western New England and are making their way to the Cape, transported by boats and birds. Hydrilla was discovered Centerville's Long Pond in 2001. The town of Barnstable and the Department of Environmental Management took immediate action to try to contain the spread of this species and are working to establish an invasive species response team and develop a comprehensive management plan to eradicate invasive species.

### **1.5.b. Vernal Pools**

Vernal pools, small water bodies that are filled with water only seasonally, are an important type of wildlife habitat and receive special protection if identified. These features serve as important spawning habitat for amphibians. A vernal pool that is within a designated wetland boundary receives some protection under the Wetlands Protection Act. Vernal pools receive special protection through the Massachusetts Natural Heritage and Endangered Species Act and under Massachusetts Surface Water Quality Standards (as Outstanding Resource Waters), but only if they are certified by the state. Many vernal pools on Cape Cod have not yet been located and/or certified and are, thus, at risk of being lost to development (RPP, 2001). Currently 92 vernal pools are certified on Cape Cod. See Table 7 for the number of certified vernal pools in each town.

Town	Number of Certified Vernal Pools
Barnstable	8
Bourne	9
Brewster	3
Chatham	1
Eastham	7
Falmouth	34
Harwich	5
Mashpee	16
Sandwich	8
Truro	1

Table 7. Certified Vernal Pools by Town.

### 1.5.c. Protecting Significant Wildlife Habitat

Among the wildlife conservation work being done on the Cape is an effort to identify and protect significant wildlife habitat areas. The Compact of Cape Cod Conservation Trusts (The Compact) initiated the Cape Cod Wildlife Conservation Project in 1997. The goal of the project was to preserve and enhance biodiversity on Cape Cod by protecting the most significant wildlife habitats against detrimental influences. Researchers identified the most important of these influences to be human population pressure and the associated land development.



The significant habitat types that were identified in the project are: salt marsh, barrier beach/dune system, ponds/lakes, riparian zone, coastal plain pond shore, vernal pools, Atlantic white cedar swamps, red maple swamps, shrub swamp, bog, freshwater marshes, sand plain grasslands, coastal heath lands, cultural field, pitch pine-oak woodland, white pine-hardwood woodland, American beech woodland, oak-hickory woodland, and pitch pine-scrub oak barrens (The Compact, 1998).

In addition to the “significant habitat” types on Cape Cod, the study also identified species associated with these habitat types; identified the shelter, breeding/nesting, and feeding needs of these species; mapped the habitats; and established a parcel assessment workbook to enable environmental planners to assign relative wildlife habitat values to individual land parcels (The Compact, 1998). The Compact provided the resulting habitat maps to most of the Land Bank Open Space Committees (upon request) in 1999-2000. New habitat analysis released by The Compact in 2002 will be used by Land Banks to identify priority parcels for conservation.

## 1.6 AIR QUALITY

The air quality of Cape Cod has been negatively impacted by exhaust from automobiles and plant emissions, from both on and off the Cape. The only air quality monitoring station on Cape Cod is in Truro. The air being monitored is not only from the Cape but also other areas to the south and west. A report issued by the Massachusetts Public Interest Research Group in 1999 stated that Barnstable County is one of seven counties in Massachusetts that regularly violates federal ground-level ozone (or smog) health standards. Barnstable County's two year average is 0.092 parts per million of ozone, whereas the federal limit is 0.085 ppm (Leaning, 1999). A ten year National Park Service study released in September 2002 found that smog levels at the Cape Cod National Seashore were among the worst in national parks throughout the country. Additionally, levels of sulfates and nitrates, the two main components of acid rain, were found to be twice the average levels at other national parks (Dooley, 2002).

Ground-level ozone is formed when volatile organic compounds (VOC) and oxides of nitrogen (from motor vehicle fueling and tailpipe emissions, and to a lesser degree from factory and power plant smokestacks) combine in sunlight. Ozone can have negative impacts on people's health by irritating the eyes, causing lung problems, and exasperating existing respiratory ailments (RPP, 2001).

The Massachusetts Department of Environmental Protection estimates that the majority of VOC emissions come from non-point sources. Stationary point sources, such as industries and utilities, contribute 6% of VOC emissions. Stationary area sources, such as residential heating systems, gasoline stations, auto body shops, and dry cleaners contribute 45% of VOC emissions. On-road motor vehicles contribute 26% and off-road mobile sources such as boats, trains, and construction and lawn equipment account for 22% of VOC emissions (RPP, 2001). Cape Cod has significant stationary area sources and mobile sources of air pollution emissions.

## 1.7 RECREATION RESOURCES

Cape Cod is well known for its numerous recreational opportunities. Public access for boaters, walking and biking trails, and federal and state parks and town and non-profit owned conservation areas are all important recreation resources on the Cape.

### 1.7.a. Public Access

The Massachusetts Public Access Board has documented 26 state run public access sites on Cape Cod. Additionally, there are town owned and maintained landings on several water bodies. While the population on Cape Cod and the demand for access to water bodies has been rapidly increasing, the number of public access points has not. This has resulted in a strong need for additional public access points on Cape Cod water bodies.



### 1.7.b. Walking Trails and Bike Paths

Cape Cod Pathways is a project of Barnstable County, administered by Cape Cod Commission staff. The goal of the project is the establishment of a dedicated network of walking paths across Cape Cod, linking the Cape's coastal areas, historic villages, and protected open space. Ultimately, the program hopes to establish walking trails in all 15 Cape towns.

Toward that end, Barnstable County has recently awarded grants to five towns to assist in the development of the Pathways network. Sandwich and Barnstable will use grant funds to assess present walking trail resources and develop plans for creating a continuous east-west trail to tie in with existing (or planned) routes in Yarmouth and Bourne; Harwich will use grant funds to plan a north-south link between the Bell's Neck Conservation Area in West Harwich with the Punkhorn Parklands in Brewster; Yarmouth will use grant funds to develop a complete system of maps and trail guides for the dedicated Pathways trail system through Yarmouth; and Brewster will use grant funds to assist with securing trail easements toward



establishment of the Brewster east-west route. Additional funds may become available for planning work in other Cape towns.

With annual and biennial events like Walking Weekend and the Cape Walk attracting hundreds of participants, the Pathways Program is a popular recreational resource. The program also functions as a component of open space planning on the Cape, as the Pathways routes take advantage of existing protected open space and undeveloped areas which may provide

important linkages between larger patches of open space.

Work continues on the Cape Cod Rail Trail, a 25 mile long trail extending between the towns of Dennis and Wellfleet. A bicycle and pedestrian bridge connecting segments of the trail is under construction in Orleans and a similar bridge was recently completed in Harwich. A plan to extend the rail trail into Chatham has just been completed, and portions of the trail in Brewster have recently undergone restoration work.

### **1.7.c. Federal Lands – Cape Cod National Seashore**

Lands owned and managed by federal, state, local, and non-profit entities provide important recreational resources on the Cape, in addition to preserving land for wildlife habitat.

The Cape Cod National Seashore (CCNS), established in 1961, is 43,500 acres of Atlantic Ocean coastline. The CCNS includes 40 miles of coastline along the Cape's outer arm in the towns of Chatham, Orleans, Eastham, Wellfleet, Truro, and Provincetown. The Seashore encircles half of the town of Wellfleet and about 70 percent of Truro, while over 80 percent of Provincetown's total area is within the National Seashore. Hundreds of families still live within its boundaries. Primary features of the CCNS include sandy beaches, uplands, woodlands, bogs, pitch pine forests, moorland, and many freshwater ponds. The park has six swimming beaches, two visitor centers, and ten nature trails. There are no public campgrounds, but private campgrounds are located in the park. With almost five million visitors in 1998, CCNS is one of the most visited parks in the National Park system.



Work is underway to seek funding for the creation of the proposed Highlands Center for the Arts and the Environment. The Highlands Center, located on the 127 acres of the former North Truro Air Force Station, would serve as a creative and collaborative working space for scientists, educators, and national park staff. It would be managed by a nonprofit organization under an agreement with the CCNS (Johnson, 2002).

### **1.7.d. State Forests and Parks**

Cape Cod has three state parks, a state forest, and a national wildlife refuge, which is a federal, state, and local partnership. These areas are of great importance as protected open space and wildlife habitat, and provide opportunities for Cape Cod residents and visitors to appreciate and become educated about the natural environment of the Cape.

#### Waquoit Bay Reserve National Estuarine Research Reserve

The Waquoit Bay National Estuarine Research Reserve (WNBERR) is a federal and state partnership and part of a system of 25 National Estuarine Research Reserves throughout the country. WNBERR has four land components – South Cape Beach State Park, Washburn Island, Quashnet River property, and the Headquarters – as well as open water and tributaries of Waquoit Bay totaling 2,600 acres. Reserve staff participates in the Mashpee National



Wildlife Refuge Management Committee to work with partners on land acquisition. WBNERR's acquisition boundary is synonymous with the Mashpee National Wildlife Refuge's acquisition boundary.

- South Cape Beach State Park contains a wide variety of coastal environments, including barrier beach and dunes, salt marsh, scrub oak/pitch pine woodland, and kettle ponds. The sandy beach is over a mile long. The park had 49,937 visitors last year.
- Washburn Island is located in Waquoit Bay. It has 11 campsites that are completely booked during the summer months.
- The Quashnet River property is co-owned with Massachusetts Division of Fisheries and Wildlife. It features an hour and a half long walking trail and catch and release fisheries in the river.
- The Headquarters consists of four buildings. The main house contains a visitors' center and exhibits. Outreach and education events are held year-round. Staff members conduct research on the Waquoit Bay and the reserve also hosts visiting researchers. Other buildings at the Headquarters provide dormitory lodging for researchers and meeting space for environmental agencies and non-profit organizations.

Priorities at WBNERR include land acquisition, ongoing maintenance of the Quashnet River, and further study of wetland hydrology at South Cape Beach State Park in order to develop a wetlands restoration plan.

#### Nickerson State Park

Nickerson State Park encompasses almost 2,000 acres in the Brewster area. It is one of the few parks that have oceanfront as well as inland lakes and ponds. Nickerson State Park also manages the 25-mile long Cape Cod Rail Trail, which runs between Dennis and Wellfleet.

The park has an amphitheater, eight miles of roads, hiking trails, an eight mile bike path that connects to the Cape Cod Rail Trail, ponds stocked with year round trout, and 418 campsites. The campsites remain full during the summer months. The park takes approximately 5,000 reservations per season, with an average 3.8 people at each campsite. In 2000, park attendance was 289,636 (Pierce, 2001). Visitors camp, swim, boat, fish, hike, bike, and attend interpretive programs offered by park staff.



The park employs two nature interpreters during the summer months. They lead bay walks and bird walks, put on campfire programs, operate a nature center, and conduct a number of other educational programs. The Friends of Nickerson State Park also conducts many interpretive programs during the summer, such as a raptor show and a reptile show.

Nickerson State Park staff outlined priorities for the park in a 1993 10 Year Goals Plan. One priority identified in the plan was to replace 13 old comfort stations. So far, six of the buildings have been completed. Other needs include repaving old roads, placing power lines in the park underground, and capital improvements such as new piping and water heaters in shower buildings.

#### Hawksnest State Park

Hawksnest State Park is a satellite property of Nickerson State Park. It covers approximately 240 acres including most of the Hawksnest Pond shoreline and some frontage on Oliver's Pond and Black Pond. Most of the property was acquired in the early 1970's with the assistance from the Land and Water Conservation Fund grant program. The latter half of the 80's saw an addition of several parcels around the western end of Oliver's Pond. It is exceptional to find undeveloped pond shorelines and such a large block of relatively undisturbed forest in this area of Cape Cod.

There are no formal recreational activities at Hawksnest with the exception of hiking and fishing. Presently, there are no plans in place for the development of this land for any purposes. There is no staff assigned to the park. Staff from Nickerson patrol the area, and survey the boundaries on a fairly frequent basis.

#### Shawme Crowell State Forest

The Shawme Crowell State Forest is the fourth largest in Massachusetts with 8,500 acres of pitch pine and scrub oak landscape. Of this acreage, 7,500 acres has been leased to the Department of Defense since 1922, which in turn leases it to the Massachusetts Military Reservation.



Recreational opportunities at the Shawme Crowell State Forest include camping, hiking, biking, horseback riding, and hunting. In 2000, the state forest was visited by 87,674 people (Pierce, 2001). The camping area in this state forest has 285 sites which are fully booked on the weekends throughout the summer. Interpretive walks are offered along with other educational programs. Environmental programs are funded by the Friends of Shawme Crowell State Forest (Smith, 2001).

#### Mashpee National Wildlife Refuge

The Mashpee National Wildlife Refuge (MNWR) was created in 1995 as a federal, state, and local partnership. Land in the refuge is owned by the United States Fish and Wildlife Service, the Massachusetts Department of Conservation and Recreation, the Massachusetts Division of Fisheries and Wildlife, the Towns of Mashpee and Falmouth, the Falmouth Rod & Gun Club, and Orenda Wildlife Land Trust. A Management Committee comprised of the various partners is in the process of developing a management coordination plan for the area. There is a Memorandum of Understanding between all the parties who own land within its



boundary, along with the Mashpee Wampanoag Indian Tribal Council, to manage their lands in a coordinated manner.

The refuge covers an area of 5,800 acres, 4,600 in Mashpee and 1,200 in Falmouth. A great variety of fish and wildlife habitats comprise the refuge, including saltwater bays, tidal marshes, Atlantic White Cedar swamps, vernal pools, wooded lowlands and uplands, mixed canopy forests, freshwater marshes and streams, kettle hole ponds, and pitch pine barrens.

When the MNWR was created, 2,800 acres were already under some form of protection. The original parcels were owned by the public, a non-profit group, and homeowners' associations in Falmouth and Mashpee. Since the creation of the refuge, 1,220 additional acres have been protected. The parcels were acquired through purchases by the towns, Mashpee Water District, Massachusetts Department of Conservation and Recreation, Massachusetts Department of Fish and Game, United States Fish and Wildlife Service, and Orenda Wildlife Land Trust. Some parcels were also acquired by the towns in the form of donations and land taken for taxes. Parcels were also acquired through Self-Help and Land Bank monies.

The MNWR Management Committee has several priority actions for the area. The biggest priority of the committee is land acquisition. There are 1,649 acres within the refuge that are still in private ownership. There is no estimate yet for the amount that these land purchases would cost, but undeveloped land on the Cape currently ranges from about \$10,000 to \$60,000 per acre. Another priority is the development of signage and a visitor center for the area. Currently the only signs identifying the area as a wildlife refuge are in a few of the town parcels. Another management issue that needs to be addressed is the lack of any full-time staff devoted to the area. A federal staff person at the Monomoy National Wildlife Refuge in Chatham devotes part of her time to the Mashpee Refuge, but the Management Committee feels that this staff time is inadequate. The Management Committee is interested in the creation of either a federal or a state position to serve as a manager for the Mashpee National Wildlife Refuge (Fudala, 2001).

#### **1.7.e. DFW Wildlife Management Areas**

The Massachusetts Division of Fisheries and Wildlife (DFW) owns and manages over 3,500 acres of land in 26 tracts of land on Cape Cod, ranging in size from the 1,900 acre Frances A. Crane Wildlife Management Area to Billingsgate Island, which now appears only at low tide. In addition to fish and wildlife habitats, the lands include numerous pond, river and coastal access points. Areas such as the Hyannis Ponds Wildlife Management Area and Mashpee Pine Barrens were purchased to protect rare species habitats, such as globally rare coastal plain ponds and pine barrens. Other land holdings include the Southeast Wildlife District Headquarters in Bourne and the Sandwich State Fish Hatchery (Hurley, 2002).

### **1.7.f. Massachusetts Audubon Society Sanctuaries**

The Massachusetts Audubon Society maintains several wildlife sanctuaries on the Cape. The Wellfleet Bay Wildlife Sanctuary in South Wellfleet is the only staffed sanctuary. Those that are unstaffed are the Long Pasture Wildlife Sanctuary in Cummaquid, the Ashumet Holly Wildlife Sanctuary in East Falmouth, and the Skunknet River Wildlife Sanctuary in Osterville. All sanctuaries are open to passive recreation (i.e. bird watching and walking).



## **1.8 SOCIOECONOMIC CONDITIONS**

### **1.8.a. Population**

Barnstable County is the third fastest growing county in Massachusetts. The population of Cape Cod increased 53% between 1970 and 1980, 26% between 1980 and 1990, and another 16% between 1990 and 2000. The increasing population spurred a dramatic increase in land development with 35,246 new housing units being built between 1980 and 1990. The 1990 year round population of Cape Cod was 186,500 (US Census Bureau, 1990) and increased to 512,500 in the summer, a 175% increase (DEM, 1994). According to the 2000 Census, more than 35,000 new residents were added to Cape Cod in the past decade, bringing the year round population to over 222,000. This represents a growth rate of 16% over the past decade. Population growth on Cape Cod leads mainland Massachusetts at three times the rate of the state at 5.2% (U.S. Census of Population, 2000). The Cape population is estimated to nearly triple from winter to summer with the arrival of tourists and summer visitors (Cape Cod Commission, 1998). See Table 8 for population by town.

Town	Population	
	Summer	Year Round
Barnstable	120,000	47,821
Bourne	41,000	18,721
Brewster	27,000	10,580
Chatham	25,000	6,625
Dennis	15,793	13,864
Eastham	7,500	5,000
Falmouth	90,000	32,700
Harwich	25,000	12,946
Mashpee	29,000	14,000
Orleans	21,000	7,000
Provincetown		
Sandwich		21,257
Truro		2,087
Wellfleet	17,500	3,184
Yarmouth	60,000	25,000

Table 8. Cape Cod Population by Town  
(Cape Cod Commission, 2002).

Barnstable County is the only county in Massachusetts where resident deaths outnumbered births between 1990 and 1997. However, Barnstable County offset that net loss with the highest net in-migration of residents of all 14 Massachusetts counties. The Cape's net in-migration estimate of 20,000 was more than triple neighboring Plymouth County's (Cape Cod Commission, 1998).

### 1.8.b. Social Conditions

A 1995 survey conducted by the Cape Cod Commission revealed that in-migrants' (people who had not lived on Cape Cod their whole life) top four reasons for deciding to move to the Cape were: 1) air and water quality, 2) safety from crime, 3) proximity to the coast, and 4) rural character. The study found that these reasons and ranking did not change between 1990 and 1995. When all respondents (including people who had lived on the Cape their whole lives) were asked whether these same conditions had gotten better or worse in the past five years, more than 40% said air and water quality, safety from crime, and the rural character had gotten worse, and fewer than 10% said these had gotten better. This suggests that, in the aggregate, respondents feel that the features of the Cape that initially most attracted them have become less attractive over the past five years (Bin and Clarridge, 1995).

In the same study, the top four concerns of residents for their communities over the next five years were water pollution (19% ranked it the number one problem), population growth (16%), tax increases (16%), and traffic congestion (12%). The next greatest concern, ranked number one by only 6% of respondents, was quality of schools. When asked about their concerns regarding personal issues, Cape Cod residents responded that they were concerned about the high cost of living and housing, and about the lack of sufficient jobs to pay what their skills are worth (Bin and Clarridge, 1995).

### **1.8.c. Economy**

The Cape Cod economic base was valued at an estimated \$1.6 billion in 1992: 44% derived from tourists and seasonal residents, 15% retirement-based income, 11% from business services, 7% from commuters, 6% from manufacturing, 5% each from marine and defense industries, and 7% from miscellaneous sources (Fiefield, CCC, 2000). The major economic industries on Cape Cod are retirement, technology, and resource-based industries such as fishing, shellfishing, recreation, and heritage tourism (RPP, 2001, p. 70). Cape Cod, together with the islands of Martha's Vineyard and Nantucket, had 4,700,000 annual person trips in 1999-2000. This accounts for 19% of all domestic travel to Massachusetts. Cape Cod and the Islands, thus, generate a disproportionately large amount of the tourism revenue coming into Massachusetts (MA Office of Travel & Tourism, 2001). In a 1995 Coast Alliance survey, coastal tourism in the northeast was estimated to be 40 times the economic value of all seafood caught in the region.

Jobs in Barnstable County reached a record high of 85,512 in 1999. The increase of 3,743 jobs from 81,769 in 1998 resulted in an annual job growth rate of 5%, more than double the 2% statewide growth rate. The job growth rate in Barnstable County from 1990 through 1999 was 22%, more than double the statewide growth rate of 9% (Fiefield, 9/18/2000). The unemployment rate for Barnstable County was 2.6% as of September 1999, slightly below the State average of 2.9% (Office of the Comptroller, 2000).

In 1989, the median household income was \$31,766, and it was estimated to be \$40,791 in 1997 (US Census Bureau, 1990). Average earnings on Cape Cod and the Islands in 1999 were \$29,670. In 1999, the resort industry accounted for 25.5 percent of the private sector jobs on Cape Cod and the islands. Allied health services accounted for 10.5%, business services 5.6%, high technology 1.7%, and other was 56.7%.

A gap exists on Cape Cod between the cost of living and average wages. According to the Massachusetts Project for Family Self-Sufficiency, 29% of Cape Cod households do not earn enough to pay for housing, food, clothing, health care, child care, and transportation without some type of public or private assistance (RPP, 2001). Approximately 46% of the Cape's year round population can be classified as low income (RPP, 2001).

Cape Cod experienced a construction boom in the mid 1980's and again in the late 1990's, which continues today.

### **1.8.d. Housing**

Barnstable County experienced the third highest growth in new housing units of all Massachusetts counties between 1980 and 1990, adding 35,000 new housing units for a total of 135,000; an increase of 35% compared to the Statewide housing growth of 12% during the same time period (Cape Trends, 1998). The number of homes on the Cape reached 150,000 in 2000, a 12% increase from 1990 (Fifield, 4/18/2000).



Affordable housing is a serious issue on Cape Cod. In 1999, the estimated median rent was \$1050 per month. A study in 2000 found that the median cost of housing was \$182,000, which is a 62% increase over the 1995 figure. It also determined that seven out of ten year round residents cannot afford the median cost of housing (RPP, 2001).

### **1.8.e. Traffic**

Traffic on Cape Cod's roads has been steadily increasing over the past few decades. From 1990 – 2000, the average change in summer traffic volume Cape-wide has been an increase of 1.5% per year, or a total of 16.05%. The year-round average for traffic crossing the Cape Cod Canal on the Bourne and Sagamore Bridges combined was 95,674 vehicles per day in 1999, or a yearly total of 34.9 million vehicles. In comparison, the summer average in 1976 was 78,790 vehicles per day, with a yearly total of 17.7 million vehicles. In January 1999, the month with the least traffic, the number of vehicles crossing the canal exceeded the 1976 traffic volumes for all months except July and August (Cape Cod Commission, Traffic Report, 2000).

To address traffic congestion during the tourist season and to meet the transportation needs of the year-round population, the Cape Cod Transit Task Force prepared the Draft Five-Year Public Transportation Plan in November 2001. The plan sets out goals, objectives, and actions for improving public transportation to, from, and within Cape Cod and the Islands. A subsequent, longer range (25 year) plan will also be prepared.

## CONCLUSIONS

The information contained in the Cape-wide Watershed Assessment and the Subwatershed Fact Sheets in the next section led the former Cape Cod Watershed Team to conclude that increased population, intense development pressures, and sprawling land use patterns on Cape Cod have resulted in increased non-point source pollution and loss of open space, habitat, and biodiversity. The key conservation issues on Cape Cod are:

- Excess nutrients such as nitrogen and phosphorous from non-point source pollution (septic systems, farms, golf courses, fertilizers, road runoff, marine discharges, wildlife, and atmospheric deposition) are degrading fresh and marine water quality and habitat. These nutrients lead to nuisance algae and plant growth, decreased water clarity and loss of shellfish and fish habitat.
- The Sagamore groundwater lens has been impacted by activities at the Massachusetts Military Reservation where plumes of contamination have tainted four public water supply wells and threatened fresh and marine waters. Similar instances of smaller scale contamination are a concern for public and private wells throughout Cape Cod.
- Water supply wells on the Outer Cape are experiencing occurrences of nitrate levels that exceed federal limits.
- Available land for development of future water supplies is disappearing as the intensity of land use increases and open space declines.
- Excessive groundwater withdrawals for drinking water and irrigation threaten the health and vitality of lakes, ponds, wetlands, and rivers by impacting water levels.
- Increased public awareness of water quality issues has led to increased bacterial testing at Cape Cod beaches, resulting in over fifty beach closings throughout Cape Cod during Summer 2001 under the MA Beaches Act.
- While the population on Cape Cod and the demand for access to water bodies has been rapidly increasing, the number of public access points has not. The result is a strong need for additional public access points on Cape Cod water bodies.
- The lack of water quality data on ponds and embayments makes it difficult to get a true understanding of what is impacting the ecosystem and the extent of the impact.
- Lack of suitable sites for locating new or expanded municipal wastewater treatment facilities is constraining attempts to channel growth into regional growth centers.
- Continued residential sprawl threatens the marine and freshwater quality of the Cape by increasing non-point source contamination and decreasing the amount of area available for natural attenuation and recharge.

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## SECTION 2. SUBWATERSHED FACT SHEETS & MAPS

Cape Cod can be divided into 47 subwatersheds. Please see the “Subwatershed Fact Sheets” section to view fact sheets for each of the 47 subwatersheds. A Watershed Resources map and Land Use map of each subwatershed are available.